JPPIPA 9(10) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Ecoliteracy of Junior High School Students through Phenomenon Based Learning on the Interaction of Living Things with the Environment

Iman Kadarisman[1,2], Indarini Dwi Pursitasari[1*], Dadang Jaenudin[1]

[1]Departement of Science Education, Postgraduate School, Universitas Pakuan, Bogor, Indonesia
[2]SMP Negeri 2 Cicurug, Sukabumi, Indonesia

Received: September 3, 2023
Revised: October 30, 2023
Accepted: November 25, 2023
Published: November 30, 2023

Corresponding Author:
Indarini Dwi Pursitasari
indarini.dp@unpak.ac.id

DOI: 10.29303/jppipa.v9i11.5180

Abstract: Ecoliteracy and Education for Sustainable Development (ESD) have received attention in achieving the Sustainable Development Goals (SDGs). Students' understanding of the environment and sustainability awareness needs to be instilled through the Phenomenon Based Learning model. This study aims to improve students' ecoliteracy through Phenomenon Based Learning on the material of the interaction of living things and the environment. The research used quasy experiment method with research design Only Pretest-Posttest Control Group Design. The research subjects were junior high school students in grade VII. Data collection techniques used tests, questionnaires, interviews and observations. Data analysis was done descriptively, N-gain calculation, and Mann Whitney test. The results showed that the average N-Gain of ecoliteracy for affective, psychomotor, spiritual, and cognitive aspects were 75.02%; 45.84%; 79.73%; and 73.31%, respectively. Mann Whitney test results showed significant differences in student ecoliteracy in experimental and control classes. Thus, it can be concluded that the implementation of learning using the PhenoBL model can improve student ecoliteracy with high categories for affective, spiritual, and cognitive aspects, while the increase in student ecoliteracy in the psychomotor aspect is classified as moderate.

Keywords: Ecoliteracy; Interaction of living things with the environment; Phenomenon_based_learning

Introduction

The era of globalization which is full of challenges and the dynamics of Science and Technology that is so rapid requires students' awareness and understanding of ecology (ecoliteracy) to achieve sustainable development goals (SDGs). According to Capra & Stone (2010), ecoliteracy is one of the most important requirements for a sustainable society in the 21st century. Ecoliteracy aims to understand and internalize the relationship between ecology and sustainable lifestyles for the future (Okur-Berberoglu, 2018). Good ecoliteracy will support sustainability awareness which is the fourth goal in the SDGs, namely the creation of education for sustainable development (ESD). Therefore, ecoliteracy needs to be familiarized since elementary education.

The results of a survey of junior high school students in Sukabumi Regency show that student ecoliteracy is still low. The percentage of students who sort organic and inorganic waste when disposing of waste is only 8.80%. Student involvement in creating small parks in the environment, preventing environmental destruction, and planting trees in arid areas is also low at 5.92% each; 29.43%; and 5.94%. In addition, only 2.91% of students participated in waste separation activities, but there were still many students who drank using cups or plastic bottles. The low survey results are in line with the results of research by Paryanti et al., (2021), that students' ecoliteracy skills are still

How to Cite:
Kadarisman, I., Pursitasari, I.D., & Jaenudin, D. (2023). Ecoliteracy of Junior High School Students through Phenomenon Based Learning on the Interaction of Living Things with the Environment. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 9075–9086. https://doi.org/10.29303/jppipa.v9i11.5180

low. Low ecoliteracy because teachers have not accustomed their students to have a good understanding and awareness of the environment in learning. A similar opinion was stated by Ekamilasari et al (2021), that the low level of sustainability awareness is caused by teachers' lack of effort to familiarize students with ecology and awareness of protecting the environment for sustainability practices, so students rarely or never take actions or decisions to understand and maintain environmental sustainability.

Based on the problems and achievements of ESD and SDGs, ecoliteracy needs to be trained to students from an early age through science learning. Thus, the problem in this study is how science learning can improve the ecoliteracy of junior high school students in Sukabumi Regency.

Based on the problem of low ecoliteracy of students in Sukabumi Regency, the effort that teachers can make is to use a learning model equipped with learning tools to improve ecoliteracy. One of the factors that influence low learning outcomes is the use of learning models that are still less varied, not adapted to the characteristics of students and learning materials (Izzati & Sukardi, 2023). Students must develop the search for answers to problems related to natural phenomena through the scientific process. Proper science learning will improve students' higher order thinking skills (Herdiana et al., 2022). The application of the model in the learning process determines the level of achievement of student learning outcomes. Successful learning is when teachers implement learning that is able to improve students' abilities and knowledge from not knowing to knowing (Maharani et al., 2023). Science learning will be more meaningful if students can relate the concepts or knowledge they gain in the classroom to real situations outside the classroom (Warouw et al., 2023). One of the learning models that can be done is the use of Phenomena Based Learning (PhenoBL) on the material Interaction of Living Things with the Environment. PhenoBL is a phenomenon-based learning model that has the main component in the form of authentic-contextual presentation of phenomena. Learning by utilizing the environment as a learning resource is contextualized learning (Sasmita et al., 2023).

Ecoliteracy is intelligence based on cognitive aspects or understanding of how the universe can support the survival of all living things. Improving ecoliteracy is very important, as it can result in positive changes in knowledge, attitudes and behaviors towards the environment (Syah et al., 2021). Ecoliteracy is complex and underpinned by intellectual, social, emotional and spiritual intelligence. The existence of knowledge, awareness, and life skills that are in harmony with the preservation of nature also increasingly supports the success of ecoliteracy. Ecoliteracy is important for students to have as one of the efforts to realize sustainable development launched by UNESCO in the fields of education and the environment (Faiqoh et al., 2019: Locke et al., 2013).

Ecoliteracy studies are important for students because they have a number of benefits that support learning and environmental awareness. The same thing was conveyed by (Gustian et al., 2022) that it is very important to instill environmental awareness to the younger generation from an early age. Through ecological knowledge, students can understand the complex relationship between humans and the natural environment. Ecological knowledge can be used more effectively in dealing with complex environmental problems (National Research Council, 1986). They will be more aware of current environmental issues, such as climate change, biodiversity loss and pollution, which are important for environmental conservation efforts. The study of ecoliteracy helps students understand the importance of sustainability and the impact of their actions on the environment. This includes aspects such as energy saving, waste reduction and rational use of natural resources. Through the study of ecological science, students are encouraged to develop their critical thinking. They learn to analyze information, evaluate arguments and make evidence-based decisions. It also helps them understand the complexity of environmental issues.

Ecoliteracy helps students appreciate the diversity of nature and life on the planet. It involves understanding different ecosystems, species and how these are interconnected. Place-based learning, adventure and outdoor education experiences can engender a sense of appreciation or positive attitude towards students' home and natural surroundings (Moonstone, 2016). Studies in ecological literacy encourage students to be socially sensitive to the environment, combine knowledge from different fields, and encourage responsible action. It helps them see the connection between science and solving environmental challenges. Students who master ecological sciences can actively contribute to environmental protection, boost self-confidence and encourage innovation. They have the potential to become leaders in environmentally friendly research and technology, as well as caring citizens capable of solving complex environmental problems.

Efforts to improve ecoliteracy have been carried out through Environmental Education (Noverita et al., 2022), the establishment of the Adiwiyata program Environmental Friendly School (Muliana et al., 2018). Environment-based teaching materials for prospective elementary school teacher students (Putu Arga, 2018), development of interactive teaching materials based on ecoliteracy (Pursitasari et al., 2021). Modules equipped with media in social studies learning (Afifah &; Rofiah, 2020), web-based science learning modules (Firdausi &; Wulandari, 2021), the use of googlemap for map making (Sutrisno &; Renggiang, 2019). In addition, increasing ecoliteracy has also been carried out using the Project-based learning model with ecobrick projects (Rahmawati et al., 2019), the project citizen model (Rahayu & Setiyadi, 2018). EDMODO-assisted POE learning strategies (Yuniar et al., 2021).

Based on the results of research related to efforts to improve ecoliteracy, there have been no studies using the PhenoBL approach. The PhenoBL learning model conditions students to observe phenomena that occur directly through practicum activities or demonstrations carried out by teachers, so that students learn more meaningfully through information obtained from these phenomena (Khanasta et al., (2016). The PhenoBL approach consists of five dimensions, namely holisticity, authenticity, contextuality, problem-based inquiry learning, open-ended learning processes (Silander, 2015) These five dimensions require students to actively participate in learning, so that students will have a meaningful understanding that is expected to increase ecoliteracy. The material that will be learned using the PhenoBL approach is the Interaction of Living Things with the Environment. This is because the material can be learned using phenomena that occur in the environment that are packaged in open-ended problems that must be solved by students. Students through science learning are expected to be able to arouse students' curiosity about objects, natural phenomena, living things, and be able to use the right procedures to deal with a new problem (Krisdiana et al., 2023).

Method

The purpose of the study is to assess the effectiveness of two learning models in improving students' ecoliteracy. The hypothesis of this research is "there is an effect of the application of Phenomenon Based Learning model on improving students' ecoliteracy. This study used Quasi Experimental Design (Creswell, 2003) with "only pretest-posttest control design" (Figure 1).

Experiment	$O_{1.E}$	X	$O_{2.E}$
Control	$O_{1.K}$	C	$O_{2.K}$

Figure 1. Only Pretest-Posttest Control Group Design

The sample is VII grade junior high school students who are divided into two groups, namely, the experimental class group using phenomenon-based learning (PhenoBL) and the control class group applying discovery learning (DL). $O_{1.E}$ and $O_{1.K}$ are pretest results in experimental and control classes, X and C are treatments, namely PhenoBL in experimental classes and discovery learning in control classes, while $O_{2.E}$ and $O_{2.K}$ are posttest results in experimental and control classes. The number of students in the experimental and control classes were 31 and 32 people. PhenoBL syntax includes presenting phenomena, observation, building concepts, conducting experiments, and communicating (Taylor, 2022). Pretest was conducted to measure the dependent variable in both groups before treatment. The purpose of the pretest is to ensure that the initial conditions of the two groups are comparable or similar. The next step provides treatment or intervention, namely providing phenomenon-based learning for the experimental class and discovery learning for the control class. After the intervention of both groups, the next step is to conduct a posttest to measure the level of ecoliteracy after the application of the phenomenon-based learning model in the experimental class and discovery learning in the control class. The next step is to analyze the data by comparing the pretest and posttest results of the two groups using the appropriate statistical method. Learning tools consisting of Lesson Plans, Teaching Materials, and Student Activity Sheets on the material of Interaction of Living Things with their Environment, have also been validated by 2 experts with an average assessment result of 100 (valid).

The results of teacher assessments of learning tools also showed CVR and CVI values of 0.97 and 0.92 respectively. Thus, based on expert and teacher assessments, learning tools using the PhenoBL model are declared valid and can be used in learning the Interaction of Living Things with their Environment.

Before and after learning using the PhenoBL model, pre-test and post-test were carried out using an ecoliteracy test instrument consisting of 37 valid questions with a reliability of 0.93. The ecoliteracy test instrument consists of 4 aspects, namely affective, psychomotor, spiritual and cognitive. Answers to questionnaires are calculated based on scores from 1 to 5. The number of affective realm statement items is 12 items, psychomotor is 19 items, and spiritual consists of 14 items. The cognitive realm consists of 5 essay-shaped questions with a maximum score of 20 questions each.

During learning, observations are made to observe the implementation of learning plans and student activities using observation sheets. This is done to observe whether the process takes place effectively from the application of models and methods used by teachers and student attitudes during the learning process. At the end of learning with the PhenoBL model, student responses or responses to the learning process they have followed are explored using questionnaires. The questionnaire distributed used the Likert scale consisting of four alternative answers, namely strongly agree (SS), agree (S), disagree (TS), and strongly disagree

(STS). The questionnaire component consists of interest, motivation, satisfaction, and responses with a total of 20 statements.

The collected data is then processed and analyzed descriptively and inferentially. The results of the pre-test and post-test ecoliteracy of students were determined to improve using the formula of Hake (1999) as follows:

$$N - gain = \frac{skor\ posttest - skor\ pretest}{skor\ maksimal - skor\ pretest} \quad (1)$$

The N-gain result, then determined the interpretation of the increase based on Table 1.

Table 1. N-Gain Score Interpretation

N-gain Score (%)	Category
< 30	Low
30 – 70	Moderate
71 – 100	High

(Hake, 1999)

Qualitative data are quantified and then calculated as a percentage using the Formula 2.

$$P = \frac{n}{N} x\ 100 \quad (2)$$

with P = Assessment percentage (%), n = number of scores obtained, and N = maximum scores

Furthermore, the results of processing student response questionnaires related to phenomenon-based learning are interpreted based on Table 2 (Arikunto, 2009).

Table 2. Student responses to phenomenon-based learning

Responds (%)	Category
$80\% < P \leq 100\%$	Excellent
$60\% < P \leq 80\%$	Good
$40\% < P \leq 60\%$	Enough
$20\% < P \leq 40\%$	Less
$P \leq 20\%$	Very Less

Result and Discussion

Implementation of Phenomenon Based Learning (PhenoBL)

Phenomenon Based Learning (PhenoBL) is based on the idea that knowledge is linked to the life of real phenomena and students can collaboratively create new solutions (Kangas &; Rasi, 2021). Learning is carried out in an experimental class, namely class 7D consisting of 31 students in semester 2 on the material of interaction of living things with the environment. There are three phenomena raised in learning, namely; ecosystem components, dependence between biotic and abiotic components, and problems resulting from human activities that have an impact on the environment.

Learning is carried out through group discussions by showing natural environmental phenomena as stimulus. Students ask questions about the phenomenon presented through learning videos. PhenoBL is learning that focuses on real-world phenomena and encourages students to ask questions about the material they are learning (Symeonidis & Schwarz, 2016). At this stage the understanding of the student's previous knowledge and the general knowledge that the student has a big hand in raising fundamental questions about the phenomenon presented. A phenomenon-based approach is a form of learning that relies on the questions asked and the material learned focusing on real-world phenomena, and the skills developed and information learned can be applied across multiple disciplines and beyond the learning environment in real-world situations. This approach is designed to engage students in learning by using real-world phenomena or complex problems as the basis for teaching and learning (Hongyim & Brunsell, 2021).

Students' knowledge of ecology and its problems will lead to questions given such as "Why worms are found in places that are a lot of garbage and damp", "What will happen to the rice field ecosystem if the existence of rice snakes is lost", "What is the impact on the environment if the cutting of trees increases, while the source of clean water is decreasing", "What will happen if the human population increases, meanwhile, food production is declining due to extreme weather changes. The question arises in learning activities when teachers show learning videos as stimuli based on real phenomena faced by humans in this century.

The next stage of the teacher facilitates students in learning through filling out Student Activity Sheets (SAS) as a medium for digging information to construct student understanding in accordance with the learning objectives to be achieved. Students explore how a phenomenon can be applied in a small miniature in an attempt to explain the theory's relationship to real life by conducting experiments according to self-made steps. This stage students try to explain related content through a series of activities by paying attention to sustainable practices such as using used items for experiments, not littering, treating living things used in practicum with compassion, not being wasteful in using water during activities, being careful in using equipment, and tidying up practicum materials and tools after they are finished using. Students do all they can to explore information related to real phenomena in their lives and strive to increase their understanding of ecology and act on sustainable awareness. Students improve their reading of ecology in revealing the phenomena faced by examining literacy related to the relationship between ecosystem components and the impact of human activities on the environment.

At this stage students will discover facts, concepts and principles through direct experience, students build their knowledge little by little through the experiences gained both from their daily lives and when conducting experimental activities. Next, students work on Student Activity Sheets by means of group discussions and class discussions. Phenomenon-based learning is a learner-centered, inquiry-based approach that engages students in problem solving and critical thinking, and supports the development of teamwork and communication skills when occurring in a collaborative environment (Esref & Cevat, 2021). Through this activity, students will naturally understand the concepts of ecoliteracy and continuous awareness without having to memorize the theory but embedded by themselves through repeated habituation during the learning process.

The final stage of phenomenon-based learning is characterized by students communicating and presenting learning outcomes in front of the entire class. This presentation is followed by a class discussion session that provides an opportunity for students to convey students' questions and opinions with full awareness in upholding justice and respect for all. During this stage, students try to explain back the real-world phenomena that students have researched as well as the activities that students have done while doing practical activities in their respective groups. Presentation and discussion sessions provide opportunities for students to develop their communication and teamwork skills, and receive feedback from their peers and teachers (Symeonidis & Schwarz, 2016).

In addition, at this stage students also have the opportunity to respond to questions and opinions from students outside the student group through discussions with the whole group. Each answer given is the result of a group discussion that considers the opinions of each group member. This shows that students not only develop personal understanding, but also appreciate and consider other people's points of view in the learning process. This is in line with Taylor's (2022) findings showing that students who were treated participated with other students during science learning by asking twice as many questions, asking more in-depth clarifying questions, and using more in-depth, and using more scientific vocabulary in student discussions compared to control group students.

This process of communication and discussion becomes a means for students to practice public speaking skills, deepen students' understanding of the phenomena studied, and broaden their horizons by accepting and responding to various points of view. Presentation and discussion sessions provide opportunities for students to receive feedback from their peers and teachers, which can help them improve their communication and teamwork skills (Adipat, 2023). Thus, this final stage of phenomenon-based learning not only strengthens students' understanding but also helps develop students' social skills and critical thinking skills holistically.

The teacher conducts continuous assessment throughout the learning process, starting from the beginning of the preliminary activity to the closing which ends with a reflection on learning. This assessment is based on activities carried out by students in a detailed and measurable manner. Teachers provide assessments to measure students' ability to explain "how" and "why" real-world phenomena occur in students' daily lives. Assessments given in phenomenon-based teaching link back to the original phenomenon or are applied to other related events (Taylor, 2022).

Furthermore, in the reflection stage, the teacher evaluates the learning that has been done and together with students, students take steps to summarize the learning results that have been achieved. This reflection process becomes an opportunity for students to understand the extent to which students' abilities have developed and to identify areas where students need to focus more on learning.

By conducting structured assessments and reflections, teachers can track each student's progress individually, understand the challenges students face, and design corrective actions accordingly. This approach ensures that phenomenon-based learning is truly effective and supports students' progress in connecting theory with the real world as well as enhancing students' understanding of the surrounding environment.

The results of the assessment of learning implementation showed an average implementation of 93.50% as shown in (Table 3). Learning the Interaction of Living Things with the Environment using the PhnoBL model is carried out well in accordance with the planned learning design.

Table 3. Implementation of PhenoBL

Lesson	Implementation Score (%)
First	95
Second	92
Third	94
Fourth	93
Average	93.50

During learning, observations are also made on student activities. Observation of student activeness includes five indicators, namely, active participation in class activities, the ability to cooperate with classmates, the ability to understand the material presented, the ability to ask and answer questions, and discipline and good attendance in class. The results of observations on student activities that have been carried out by four observers are in Figure 2.

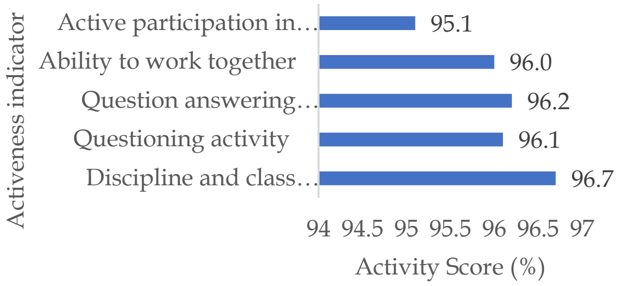

Figure 2. Results of observations on student activeness

Figure 2 shows the percentage of student activeness indicators during four phenomenon-based learning meetings in the experimental class. The results showed that students showed the highest level of discipline during learning. In addition, students also have good abilities in asking and answering questions, and are able to cooperate with classmates well. The active participation of students in various classroom activities is also striking. Increased student discipline is an indication that phenomenon-based learning has created an environment that supports discipline and regularity in learning. Phenomenon-based learning, which emphasizes real-world phenomena and multidisciplinary approaches, can create an engaging and challenging learning environment that encourages students to take responsibility for their learning (Meşe & Sevilen, 2021). The ability of students to ask and answer questions also indicates the level of understanding and involvement of students in the learning process. In addition, good collaboration with classmates shows that students can work well together in seeking mutual understanding and solutions. Collaboration skills contribute to the achievement of students' conceptual knowledge because collaboration activities allow students to be active in the learning process (Alphrazy & Octavia, 2023).

Students' active participation in classroom activities reflects students' level of enthusiasm and interest in phenomenon-based learning. The act of engagement in classroom activities is operationally defined as active participation and passive participation (Aziz et al., 2018). The more active student participation, the more likely students are to be thoroughly involved in the learning process and get the maximum benefit from this learning approach.

The results of data processing that show a student activity rate of 96.6% is a very good achievement in the context of phenomenon-based learning on the material of interaction of living things with the environment. This figure indicates that students are very actively and enthusiastically involved in the learning process, showing a high interest in learning that focuses on real phenomena around students. This high student activity certainly does not just happen, but is the result of effective phenomenon-based learning design. This learning approach creates an engaging and interactive learning environment, allowing students to understand the subject matter in greater depth. The material presented uses examples of real-world phenomena, which makes students feel connected and see the direct relevance of the concepts learned to students' daily lives.

In addition, student activeness also indicates that motivation in phenomenon-based learning is very high. This approach encourages activity and participation among students, which can increase their motivation (Esref & Cevat, 2021). Students feel drawn to seek answers to questions that arise from observed phenomena, and Students feel motivated to explore more deeply to understand the interaction of living things with the environment. As a result, the learning process becomes more meaningful and enjoyable for students, which has a positive impact on students' enthusiasm for learning. By actively engaging in the exploration of natural phenomena and the interaction of living things with the environment, students become more sensitive to environmental issues and the impact of human actions on ecosystems. Students realize the importance of sustainability and conservation of natural resources, and this influences students' attitudes and behaviors in everyday life.

Overall, interviews with four teachers who participated directly as observers showed that phenomenon-based learning is an innovative approach. At first, students perceive this approach as having similarities to the problem-based learning model. However, over time, students realize the effectiveness of phenomenon-based learning. This influence can be seen from the dynamism of student activities in core learning activities, especially during presentations and class discussions. The observations also showed an increase in student participation at each meeting. This is in line with Taylor's (2022) conclusion that learning is best achieved by students actively building their own Student experiences and by having students build Student knowledge socially in groups while asking questions

Student Ecoliteracy

The results of pretest before implementation and posttest after the implementation of phenomenon-based learning in experimental classes and conventional learning in control classes can be seen in Table 4.

Table 4. Ecoliteracy Pretest and Posttest Results

Group	Test Implementation	Number of Students	Lowest Value	Highest Value	Average	Standard deviation
Experiment	Pretest	31	42	69	54.00	7.492
	Posttest	31	76	93	85.32	5.095
Control	Pretest	32	52	77	59.72	7.916
	Posttest	32	54	84	68.53	6.633

The application of Phenomenon-Based Learning (PhenoBL) in experimental classes has shown significant results in increasing students' average ecoliteracy scores when compared to control classes. This fact is also supported by research Wakil et al., (2019), that PhenoBL can improve understanding and students' engagement in the subject being taught increases thereby improving their learning ability and skills. their skills. In line with the results of research conducted by (Esref & Cevat, 2021) show that the effect of the phenomenon-based learning approach on students' metacognitive awareness. The PhenoBL model provides students with an immersive learning experience in understanding ecoliteracy, especially related to the interaction of living things with the environment. This approach pays attention to the affective, spicomotor, spiritual, and cognitive domains in the learning process, so that students can develop a more holistic understanding of the ecosystem and environment around students.

In the early stages of learning, students are invited to observe phenomena that occur around students' lives. In the process of observing these phenomena, students are empowered to be more sensitive to the interaction between living things and the environment around them. For example, students can observe the life cycle of plants or animal behavior in the wild, as well as the impact of environmental changes on the lives of those living things. Through direct observation, students can experience learning that is authentic and relevant to everyday life.

Furthermore, in the implementation of PhenoBL, students are encouraged to integrate various domains of student understanding, including affective (emotions and feelings), psychomotor (physical skills), spiritual (values and ethics), and cognitive (knowledge and understanding). Through this approach, students not only acquire knowledge about ecosystems, but also understand the importance of biodiversity, interdependence between living things, and responsibility as part of the environment.

In addition, PhenoBL also strengthens students' sense of involvement in learning because students are actively involved in identifying problems and finding solutions through investigation and exploration of phenomena. This helps students to become more independent, critical, and creative learners. That way, PhenoBL learning does not only focus on accumulating facts and information, but rather on developing critical thinking and problem solving.

The application of Phenomenon-Based Learning (PhenoBL) opens up great opportunities for students to develop deep and thorough ecoliteracy. By observing the phenomena around the Student, students can better connect with the environment and understand more strongly the importance of ecosystem balance. PhenoBL provides a learning context that is relevant to real life, so that students become more engaged and enthusiastic in understanding and active in protecting the environment for a sustainable future. This is evident from the striking difference in N-Gain values between the experimental and control class groups, as seen in Figure 3.

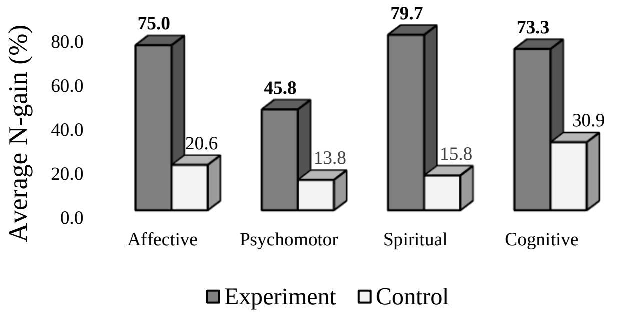

Figure 3. Average N-Gain of Student Ecoliteracy

The mean affective N-Gain in the experimental class was higher than in the control class. Students in experimental classes exhibit behaviors that reflect care, empathy, and respect for others and living beings. Students are also able to see and appreciate multiple perspectives, work with different backgrounds, and have different motivations and intentions. This shows that the students in the experimental class have developed a good ecoliteracy attitude. This is due to the use of environment-oriented learning methods, increasing students' knowledge and awareness of environmental issues, habituating environmentally friendly behavior through practices and activities carried out in experimental classes, as well as environmental support and influences outside the classroom. In addition, other studies also show that learning programs that are integrated with environmental topics can improve students' knowledge, attitudes, and behavior in managing the environment sustainably (Etmagusti, 2010).

The average N-Gain score from the psychomotor realm, it can be seen that experimental class students have a relatively low psychomotor level. Students are still less concerned in practicing the use of tools, objects, and procedures for a sustainable society. Students need to further enhance their ability to transform beliefs into practical and effective action and apply ecological knowledge to ecological design practices, attitudes to action, and assess and adjust energy and resource use. This can be caused by several factors, such as lack of exercise and habituation in performing psychomotor activities, as well as lack of attention and support from the environment around students in developing psychomotor abilities. In improving students' psychomotor abilities in the understanding of ecoliteracy, habituation and structured exercises are needed. Learning that is structured and integrated with psychomotor aspects can improve students' psychomotor abilities (Hendriyan, 2013).

The average N-Gain percentage for the spiritual realm showed that students in the experimental class had higher scores than the control class. Students in the experimental class show outstanding attitudes and behaviors, including feeling wonder and admiration for nature, respecting the earth and all living things, and having a strong bond and deep appreciation for a place. In addition, students are also better able to feel kinship with nature and are able to transmit these feelings to others. The increase in N-gain in the spiritual realm with a high category is due to learning with the PhenoBL model, students have been accustomed to being grateful for the blessings God gives through praying activities at the beginning of learning. The concept of ecoliteracy is a perspective offered by Fritjof Capra in the philosophy of ecological science which is actually very close to spiritual values (Habaora et al., 2020).

The cognitive realm in the experimental class showed a greater average N-Gain compared to the control class. This shows that the application of Phenomenon-Based Learning (PhenoBL) is able to increase students' understanding of the competence of basic ecological principles when compared to conventional learning models applied in control classes. Students in the experimental class showed a better understanding of the competence of basic principles of ecology. PhenoBL also helps students get better grades in their exams. Retaining learned skills and better grades is an excellent facts that can show the positive impression of PhenoBL in students' overall knowledge (Wakil et al., 2019). Students are able to explain the concept of the environment and its components, understand the interactions between living things in ecosystems, describe patterns of interaction in these ecosystems, and distinguish between food chains and food webs, as well as detritus food chains with grazing food chains. Phenomenon-based learning carried out with a project approach, direct experiments and role play and supported by environmentally friendly media in this study, is proven to improve cognitive aspects related to ecoliteracy. In addition, the use of media and technology in learning can also help increase students' understanding of environmental issues (Etmagusti, 2010).

Thus, PhenoBL proves its effectiveness in improving the cognitive aspects of students, specifically in understanding complex ecological concepts. The application of the PhenoBL approach provides an opportunity for students to experience more active learning and be directly involved in the process of understanding the material of the interaction of living things with the environment. Based on the N-gain results, to determine the significance of the increase that occurred, an inferential test was carried out starting with the normality test, the normality test result data is presented in Table 5.

Table 5. Results of Student Ecoliteracy Normality Test in Experimental Class and Control Class

Class	Shapiro-Wilk		
	Statistic	df	Sig.
Experiment	0.92	31	0.02
Control	0.98	32	0.77

In the experimental class, the results of the normality test using the Shapiro-Wilk test showed that the data were normally distributed. Furthermore, a homogeneity test of variance was carried out with the results contained in Table 6. The homogeneity test results show that the final value score data has a homogeneous variance with a significance value greater than 0.05. After confirming the normality assumption was not met but the homogeneity assumption was met, the next step was to use the Mann-Whitney test to determine the significance of the increased ecoliteracy of students in both groups.

Table 6. Test Results of Homogeneity of Experimental and Control Groups

Variabel	Levene Statistic	df1	df2	Sig.
Based on Mean	0.73	1	61	0.39
Based on Median	0.66	1	61	0.42
Based on Median and with adjusted df	0.66	1	49.79	0.42
Based on trimmed mean	0.72	1	61	0.39

The Mann-Whitney test was used to compare students' improvement in ecoliteracy in both groups. This process is an important part in ensuring the validity and reliability of the analysis results and providing strong confidence in concluding research results. The results of the Mann-Whitney Test for ecoliteracy aspects are presented in Table 7.

Table 7. Mann-Whitney Test Results Ecoliteracy Aspect

	Hasil Ekoliterasi
Mann-Whitney U	20000
Z	-6.56
Asymp. Sig. (2-tailed)	0,00

The results of the Mann-Whitney test showed that there was a significant difference in the increase in student ecoliteracy between the experimental class and the control class with a significance value of less than 0.05. The results of the Mann-Whitney test showed a significant difference in improving student ecoliteracy. This means that there is a very real influence of the application of the phenomenon-based learning model (PhenoBL) in experimental classes in improving student ecoliteracy, compared to the *discovery learning learning* model applied to control classes. These findings are very important because they show the clear benefits of PhenoBL in the context of learning. In phenomenon-based learning, students are invited to observe phenomena that occur around students and find solutions to problems that arise. This learning can be done by various methods, such as project-based learning, environment-based learning, and experience-based learning (Pareken et al., 2015).

The application of PhenoBL in experimental classes provides a more interesting and relevant learning experience for students. Through the exploration of real phenomena in learning, students feel more connected to the subject matter and see how theoretical concepts can be applied in everyday life. The active and interactive learning process in PhenoBL also encourages students to more actively participate in discussion, collaboration, and problem solving, thus strengthening students' understanding and skills.

These findings also confirm that PhenoBL can be an effective alternative in improving student ecoliteracy. By focusing more on real phenomena that occur in the environment, students become more sensitive and concerned about environmental issues, such as natural resource conservation, sustainability, and the role of humans in ecosystems. The application of PhenoBL can prepare students to become environmentally conscious and responsible individuals in maintaining the sustainability of our planet.

The benefits of PhenoBL not only have an impact on aspects of improving ecoliteracy, but also have a positive impact holistically on the teaching-learning process. More active student engagement and high motivation improve the quality of learning and reduce boredom levels in the classroom. This results in better student retention and understanding rates, as well as increased student participation in class.

In conclusion, the results of the Mann-Whitney test confirmed that the application of PhenoBL in experimental classes had a more positive influence in improving student ecoliteracy compared to conventional learning models applied to control classes. Although the data were not normally distributed, the non-parametric analysis still provided meaningful and relevant information about the differences in ecoliteracy between the two groups. These findings demonstrate the significant benefits of PhenoBL in the context of learning, as well as its potential as an effective alternative in increasing students' ecoliteracy understanding and awareness. Thus, the application of PhenoBL can be considered as a strategic choice in improving the quality of education and producing young people who care about the environment.

Student Response to PhenoBL Implementation

Student responses were obtained through response questionnaires from thirty-one students by answering 20 points of statements developed through four indicators, namely interest, motivation, satisfaction and responses. The form is a closed questionnaire using the Likert scale with 4 scales. The statement is designed to assess various aspects of the implementation of phenomenon-based learning in increasing student ecoliteracy on the material of interaction of living things with the environment. The results of student responses after participating in learning the Interaction of Living Things with the Environment using PhenoBL are contained in Table 8.

Table 8. Student Response to Learning

Indicator	Respon Siswa (%)	Kategori
Interest	94.72	Very good
Motivation	95.34	Very good
Satisfaction	93.10	Very good
Activity	84.52	Very good
Average	91.92	Very good

Table 8 shows that the average score of student responses is 91.92% with the category of very good. This shows that overall students give a positive response to phenomenon-based learning on the material of interaction of living things with the environment. Most students strongly agree that phenomenon-based learning makes science learning more enjoyable. Students are interested in learning topics with natural or real-world phenomena, and are enthusiastic when the subject matter is presented using examples of phenomena from everyday life. In addition, students enjoy learning about concepts of phenomena illustrated by real cases or experiments of phenomena. Students also feel happy and curious when learning begins with questions related to real-world phenomena and feel excited when working on assignments or projects that involve identifying real-world phenomena relevant to the subject matter. Pareken et al., (2015) also stated that phenomenon-based learning models can attract students' learning interest because in this model students are required to find physics concepts through problems given by teachers from phenomena that are often encountered in everyday life. In line with the opinion of Simatupang et al., (2017) stated that a very important factor and can foster students' enthusiasm for learning. In phenomenon-based learning, students are required to be active in making observations from daily activities related to phenomena so that it requires high motivation from students. By actively involving students in the learning process, PhneoBL prepares the younger generation to become environmentally conscious individuals, contributing to sustainable.

Conclusion

Phenomenon Based Learning is learning that emphasizes providing real phenomena in students' lives to improve student ecoliteracy. Learning is carried out well in accordance with the learning design. Students are also actively involved during the collaborative learning process. Learning involves discussion, exploration, experimentation, and presentation. Learning outcomes not only improve cognitive aspects, but also affective, psychomotor, and spiritual aspects. Students gave a very positive response to the implementation of Phenomenon Based Learning in the material Interaction of living people with the environment. Learning using the PhenoBL model can significantly improve student ecoliteracy. Students are actively involved in observing phenomena, integrating understanding from diverse aspects. Results show improved attitudes and understanding of ecoliteracy. Although the data is not normal, PhenoBL is still useful in improving ecoliteracy. Student response is very positive to learning.

Acknowledgments
We would like to thank the Directorate of Research, Technology, and Community Service (DRTPM) of the Ministry of Education, Culture, Research, and Technology through the Master Thesis Research Grant for Fiscal Year 2023 with contract number 180/E5/PG.02.00.PL/2023.

Author Contribution
Iman Kadarisman conceptualized the research idea, designed the methodology, analyzing data, conducting the research process, investigation, and drafting the initial draft. Indarini Dwi Pursitasari conceptualized the research idea, designed the methodology, management, coordination responsibilities, literature review, writing and writing review and editing. Dadang Jaenudin provided feedback, critical input on the manuscript and supervision.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Adipat, S. (2023). An Artificial Intelligence-Enhanced Phenomenon-Based Learning Approach for Interdisciplinary Understanding and Speaking Skills. *International Journal of Instruction*, *16*(3), 531–550. https://doi.org/10.29333/iji.2023.16329a

Afifah, S. N., & Rofiah, L. (2020). Pengembangan Sumber Dan Media Pembelajaran Ips Untuk Meningkatkan Ecoliteracy Peserta Didik. *Jipsindo*, *7*(2), 136–161. https://doi.org/10.21831/jipsindo.v7i2.34938

Alphrazy, R., & Octavia, B. (2023). Effectiviness of Student Teams Achievement Division and Scrambel Combined Model on Collaborative Skills and Conceptual Knowledge Mastery of Class X SMAN 1 Semparuk on Bacteria. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4783–4790. https://doi.org/10.29303/jppipa.v9i6.3544

Arikunto, S. (2009). *Prosedur Penelitian Suatu Pendekatan Praktik*. Rineka Cipta.

Aziz, F., Quraishi, U., & Kazi, A. S. (2018). Factors behind classroom participation of secondary school students (A gender based analysis). *Universal Journal of Educational Research*, *6*(2), 211–217. https://doi.org/10.13189/ujer.2018.060201

Ekamilasari, E., Permanasari, A., & ... (2021). Critical Thinking Skills and Sustainability Awareness for the Implementation of Education for Sustainable Development. *… of Science Education …*, *1*(1), 121–124. https://journal.uny.ac.id/index.php/jser/article/view/41753

Esref, A., & Cevat, E. (2021). The effect of phenomenon-based learning approach on students metacognitive awareness. *Educational Research and Reviews*, *16*(5), 181–188. https://doi.org/10.5897/err2021.4139

Etmagusti. (2010). Efektivitas Ekoliterasi dalam Meningkatakan Pengetahuan, Sikap dan Perilaku Masyarkat Mengenai Education for Sustainable Development Berbasis Tanaman Pangan Lokal. *Jurnal Pertanian Berbasis Keseimbangan Ekosistem*, *13*(1).

Faiqoh, N., Karyanto, P., & Indrowati, M. (2019). Karakteristik Pengembangan Media Pembelajaran untuk Menguatkan Ekoliterasi Siswa SMA di Era Revolusi Industri 4.0 Characteristics of Learning

Media Development to Strengthen Senior High School Students Eco-Literacy in The Industrial Revolution 4.0 Era. *Proceeding Biology Education Conference*, *16*(1), 87–93. https://jurnal.uns.ac.id/prosbi/article/view/38399

Firdausi, A., & Wulandari, F. E. (2021). Development of Web-Based Science Learning Module in Improving the Students' Understanding of Eco-Literacy. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *5*(3), 241–252. https://doi.org/10.36312/esaintika.v5i3.426

Habaora, F., Riwukore, J. R., Adiwibowo, S., & Susanto, Y. (2020). Falsafah sains ekologi Fritjof Capra dan relevansinya dengan kearifan lokal. *Jurnal Kebudayaan*, *15*(1), 41–51. https://jurnalpuslitjakdikbud.kemdikbud.go.id/index.php/kebudayaan/article/view/327

Hake, R. R. (1999). *ANALYZING CHANGE/GAIN SCORES*. *1*(1), 16–22. https://doi.org/10.24036/ekj.v1.i1.a10

Hendriyan. (2013). Analisis Kemampuan Psikomotor Siswa Pada Pembelajaran Hands On Teknik Challenge Exploration Activity. *Universitas Islam Negeri Syarif Hidayatullah*, 112.

Herdiana, L. E., Sunarno, W., & Indrowati, M. (2022). Feasibility of Inquiry-Based Science E-Module Guided by Material Interaction of Living Beings with Environmental Learning Resources to Improve Science Literacy. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 2697–2704. https://doi.org/10.29303/jppipa.v8i6.2023

Hongyim, K., & Brunsell, E. (2021). Identifying teacher understanding of phenomena-based learning after professional development. *Journal of Physics: Conference Series*, *1957*(1). https://doi.org/10.1088/1742-6596/1957/1/012039

Izzati, H., & Sukardi, S. (2023). Implementasi Model Outdoor Learning Terhadap Hasil Belajar. *Journal of Classroom Action Research*, *5*(1). https://jppipa.unram.ac.id/index.php/jcar/article/view/3460%0Ahttp://jppipa.unram.ac.id/index.php/jcar/article/download/3460/2311

Kangas, M., & Rasi, P. (2021). Phenomenon-Based learning of multiliteracy in a Finnish upper secondary school. *Media Practice and Education*, *22*(4), 342–359. https://doi.org/10.1080/25741136.2021.1977769

Khanasta, I., Sinon, I. L. S., & Widyaningsih, S. W. (2016). Penerapan Model Pembelajaran Berbasis Fenomena Menggunakan Metode Demonstrasi Terhadap Berpikir Kritis Peserta Didik Kelas XI IPA SMA Yapis Manokwari. *Wahana Didaktika*, *14*(September), 1–161.

Krisdiana, M., Goliah, M., Malihah, S., Nulhakim, L., & Leksono, S. M. (2023). Effect of Science LKPD Based Surrounding Environment on Learning Outcomes of Elementary School Students. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 3915–3922. https://doi.org/10.29303/jppipa.v9i5.3555

Locke, S., Russo, R., & Montoya, C. (2013). Environmental education and eco-literacy as tools of education for sustainable development. *Journal of Sustainability Education*, *4*(January), 10.

Maharani, F., Asrin, & Midodo, A. (2023). Pengaruh Model Project Based Learning Terhadap Keaktifan Belajar dan Retensi Siswa. *Journal of Classroom Action Research*, *5 (1)*, 347–355. https://doi.org/10.29303/jcar.v5i1.3619

Meşe, E., & Sevilen, Ç. (2021). Factors influencing EFL students' motivation in online learning: A qualitative case study. *Journal of Educational Technology & Online Learning*, *4*(1), 11–22. http://dergipark.org.tr/jetolDoi:http://doi.org/10.31681/jetol.817680

Muliana, A., Maryani, E., & Somantri, L. (2018). Ecoliteracy Level of Student Teachers (Study toward Students of Universitas Syiah Kuala Banda Aceh). *IOP Conference Series: Earth and Environmental Science*, *145*(1). https://doi.org/10.1088/1755-1315/145/1/012061

Noverita, A., Darliana, E., & Darsih, T. K. (2022). Pendidikan Lingkungan Hidup untuk Meningkatkan Ecoliteracy Siswa. *Jurnal Sintaksis*, *4*(1), 51–60. http://jurnal.stkipalmaksum.ac.id/index.php/Sintaksis/article/view/248%0Ahttp://jurnal.stkipalmaksum.ac.id/index.php/Sintaksis/article/download/248/249

Okur-Berberoglu, E. (2018). Development of an ecoliteracy scale intended for adults and testing an alternative model by structural equation modelling. *International Electronic Journal of Environmental Education*, *8*(1), 15–34.

Pareken, M., Patandean, A. J., & Palloan, P. (2015). Penerapan Model Pembelajaran Berbasis Fenomena terhadap Keterampilan Berpikir Kritis dan Hasil Belajar Fisika Peserta Didik Kelas X SMA Negeri 2 Rantepao Kabupaten Toraja Utara. *Jurnal Sains Dan Pendidikan Fisika (JSPF)*, *11*(3), 214–221.

Paryanti, S., Pursitasari, I. D., & Rubini, B. (2021). Ecoliteracy of Junior High School Students in Science Lesson on Environmental Pollution Theme. *Scientiae Educatia*, *10*(1), 12. https://doi.org/10.24235/sc.educatia.v10i1.8073

Putu Arga, H. S. (2018). Application of Project Based Learning Models To Improve Ecoliteracy of Elementary School Students Through Urban Farming Activities. *PrimaryEdu - Journal of Primary*

Education, 2(2), 95. https://doi.org/10.22460/pej.v2i2.1014

Rahayu, G. D. S., & Setiyadi, R. (2018). Penerapan Model Project Citizen dalam Upaya Meningkatkan Kecerdasan Ekologis. *Mimbar Sekolah Dasar*, *5*(1), 31. https://doi.org/10.17509/mimbar-sd.v5i1.9684

Rahmawati, A., Supriatna, N., & Mulyadi, A. (2019). Ecoliteracy in Utilizing Plastic Waste To Ecobrick Through Project Based Learning on Social Studies Learning. *International Journal Pedagogy of Social Studies*, *4*(2), 101–106.

Sasmita, N. N. N., Ayu Lestari, T., & Bahri, S. (2023). Pemanfaatan Lingkungan Sekolah Sebagai Sumber Belajar pada Materi Klasifikasi Makhluk Hidup untuk Meningkatkan Hasil Belajar Siswa. *Journal of Classroom Action Research*, *5*(2). http://jppipa.unram.ac.id/index.php/jcar/index

Silander, P. (2015). Rubric for Phenomenon Based Learning. *Phenomenal Education*. http://www.phenomenaleducation.info/phenomenon- based-learning.html

Simatupang, S. N. B., Islami, N., & Nasir, M. (2017). Hubungan Motivasi Belajar dan Self-Regulated Learning dengan Hasil Belajar Fisika Siswa Kelas XI SMA Negeri 4 Pekanbaru TahunPelajaran 2016/2017. *Jurnal Online Mahasiswa FKIP Universitas Riau*, *4*(2), 1–12. https://jom.unri.ac.id/index.php/JOMFKIP/article/view/15927

Sutrisno, B., & Renggiang, S. (2019). Pemanfaatan Google Maps Dalam Pembuatan Peta Khusus Untuk Meningkatkan Ecoliteracy Peserta Didik. *Jurnal Didaktika Pendidikan Dasar*, *3*(2), 379–394.

Syah, N., Hidayat, H., Yuca, V., Ardi, Z., & Magistarina, E. (2021). Examining the Effects of Ecoliteracy on Knowledge, Attitudes, and Behavior through Adiwiyata Environmental Education for Indonesian Students. *Journal of Social Studies Education Research*, *12*(4), 209–230.

Symeonidis, V., & Schwarz, J. F. (2016). Phenomenon-Based Teaching and Learning through the Pedagogical Lenses of Phenomenology: The Recent Curriculum Reform in Finland Vignetten-und Anekdotenforschung Universität Innsbruck View project. *Forum Oświatowe*, *February 2017*, 30–47. https://www.researchgate.net/publication/313696751

Taylor. (2022). *Phenomenon-Based Instruction in the Elementary Classroom: Impact on Student Engagement and Achievement in Science Content Learning*. *May*.

Wakil, K., Rahman, R., Hasan, D., Mahmood, P., & Jalal, T. (2019). Phenomenon-Based Learning for Teaching ICT Subject through other Subjects in Primary Schools. *Journal of Computer and Education Research*, *7*(13), 205–212. https://doi.org/10.18009/jcer.553507

Warouw, Z. W. M., Boyong, F. A., Suriani, N. W., Wowor, E. C., & Tumewu, W. A. (2023). The Effect of Outdoor Study Method Based on Democratic Learning in Improving Junior High Students' Learning Outcomes in Science Subject. *Jurnal Penelitian Pendidikan IPA*, *9*(2), 527–533. https://doi.org/10.29303/jppipa.v9i2.2630

Yuniar, Y., Sopandi, W., on, A. S.-I. C., & 2021, undefined. (2021). The Effect of POE Learning Strategy Assisted by Edmodo On Eco literation In Elementary School. *Proceedings2.Upi.Edu*, *2020*(1), 482–488. http://proceedings2.upi.edu/index.php/icee/article/view/1504